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THE OUTLOOK OF ELECTRICITY.

It has often been remarked that of all the sciences there is none which has been of more vigorous and rapid development than electricity. Long hidden in the dark womb of nature, like a spellbound genie, or a faculty asleep in the soul, it has within these latter generations sprung into quick existence, growing like a giant, and doing a giant's work. With all its practical power there is a brilliancy about its marvellous effects, which renders it a most fascinating pursuit, the most fascinating science of all perhaps. And this very shining quality has had an untold effect in furthering its own increase. The minds of men, however philosophical they may be, are ever fascinated by the miraculous and lured by beauty. What wonder then that electricity, whose effects are so beautiful, and withal so miraculous that to the uninitiated they seem to be creations of the magician, should number among its admirers and votaries all kinds and conditions of men. It has been said that a science progresses by the compound interest law, but electricity, at least, is an exception to this rule. The recent burst of electric invention, indeed, points to a more complex order of development than can be expressed by any known formula. Human genius, an altogether incalculable thing, must be taken into account in science, even as it is taken into account in poetry. The telephone and the microphone are pregnant factors in the advance of electrical science, corresponding to cataclysms in the uniform process of evolution. They have of late carried the science forward by a jump, and it is natural now to pause and view the outlook ahead.

The Victorian era will be ever memorable in history as the nurse of the steam-engine, of gas lighting, and of the electric telegraph. But it does not require a prophetic eye to foresee the time when electricity will supersede both gas and steam. Man uses first those resources of nature which are nearest to him, then seeks out and utilises those which lie deeper. He hunts the wild animal crossing his path, then herds it on the grass, then tills the surface soil, then digs up coal and metals from the bowels of the earth, and at last when these palpable resources begin to fail his hand and sense, he looks into the secret store-room of matter with the eye of intellect, and discovers new mines of power even richer than the old. At present we are consuming one hundred and fifty million tons of coal per annum, and this waste cannot go on for ever. Our coal fields will inevitably become exhausted. But shall it then be necessary to buy our coal from other countries, say from our more prosperous "kin beyond the sea," as Mr. Gladstone poetically calls our American cousins, who doubtless in the shabby future which that fermenting patriot gratuitously depicts for his countrymen, will despise their impecunious relative and, at the same time, grow fat upon her poverty. Perhaps not. Perhaps the electro-motor will worthily replace the superannuated steam-engine; and the restless waves which ring our rocky coasts, the cascades which foam from our highland fells, will relieve us from the necessity of filling the Yankee purse, and carrying the wherewithal to keep us warm, and turn our mills, and lighten our darkness, over two thousand miles of stormy sea. The electric light is now fairly equipped as a formidable rival of coal gas. For large works and public squares, where a few light centres suffice, it is in every way superior to gas, at a smaller cost; and if it could be distributed with less loss of energy and at smaller expense, it would speedily take the place of gas for street lighting also. It is certain to become a dangerous competitor against coal gas, and unless the latter is improved in quality and reduced in cost, its employment will by no means be so universal as it is at present.

The possible applications of electricity are indeed, legion. Every day sees a new one. Its great mission is manifestly that of a vehicle of energy, and it appears to be capable of reproducing all modes of motion. If it is true that all the known forms of energy are mutually convertible, then electricity will probably be the practical channel of this transformation. We have seen during these latter years how magnetism, heat, and sound, can be transported into space by the electric current. In the future, near or remote, it will in all likelihood wing the shafts of light, and as men now hear by telegraph, so will they see. Nerve force is surely a form of physical energy too; and with the fair prospect which we have before us, it is hardly too daring an imagination to anticipate the time when sensation itself may be transformed into electricity, and pain and pleasure sent by wire.

THE MAGNETO-ELECTRIC MACHINE OF M. DE MÉRITENS.

By TH. DU MONCEL.

The commercial and industrial field, opened up lately by the electric light given by magneto-electric induction machines, has led, on all sides, to researches and improvements which have considerably advanced the problem of electric lighting. Everyone now knows the beautiful machines which MM. Siemens, Gramme and Lontin con-

HALF ELEVATION A HALF SECTION.

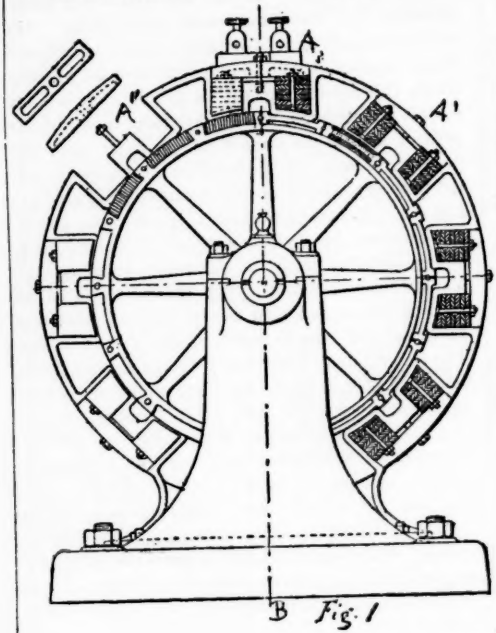


Fig. 1

Plan.

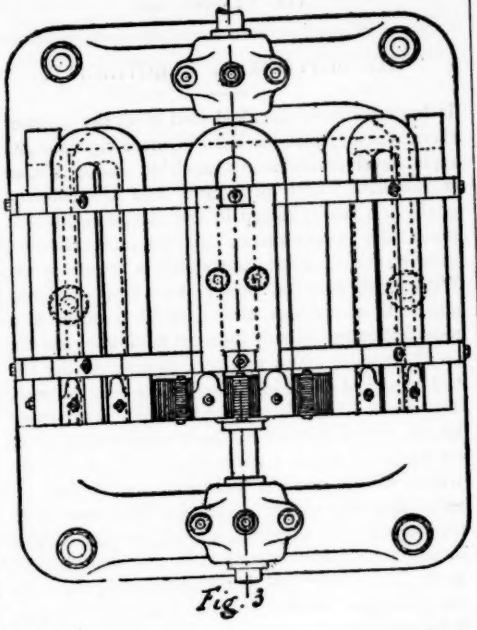


Fig. 3

SECTION A B.

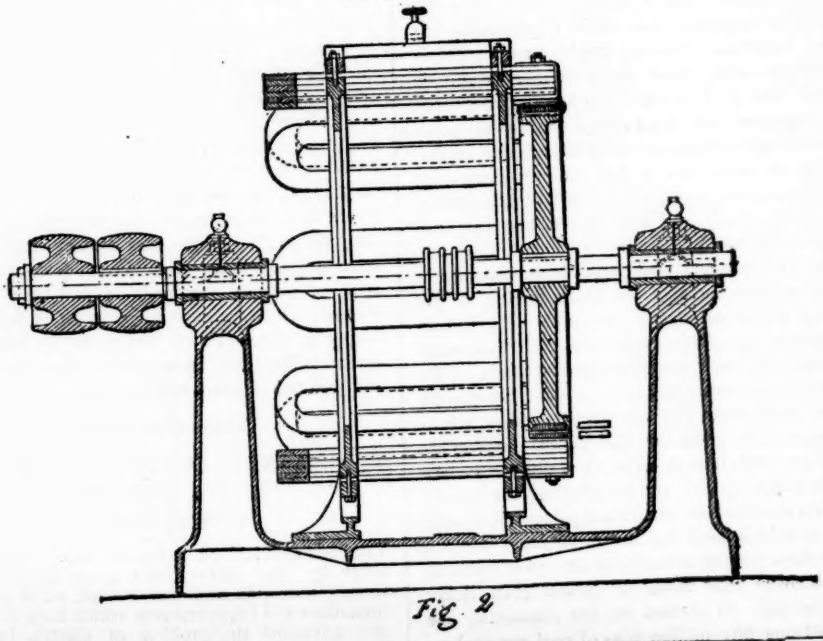


Fig. 2

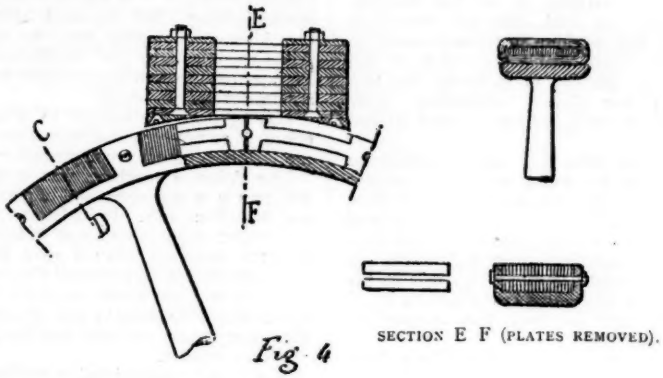


Fig. 4

SECTION E F (PLATES REMOVED).

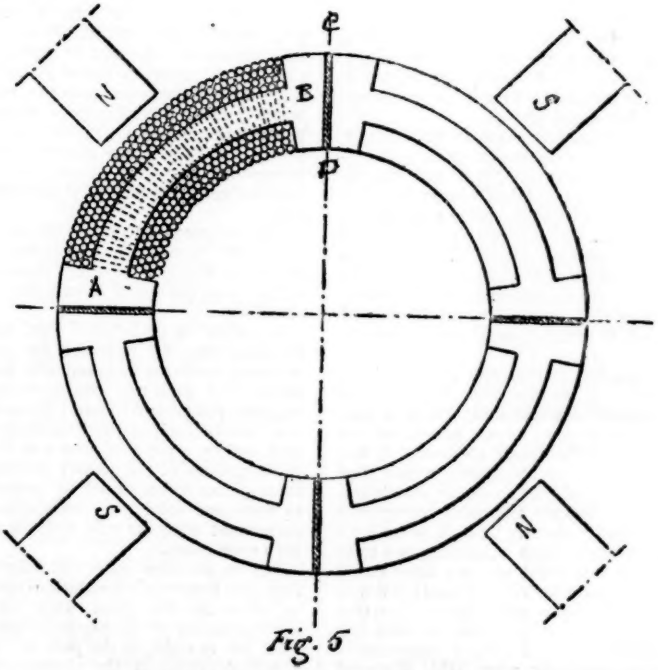


Fig. 5

DETAILS OF THE COILS AND MAGNET SECTION C D.

struct, and one might have thought on looking at them that it would be difficult to bring them to further perfection. However, we believe that the final solution of the problem is not yet attained, and it is probable we shall soon see something better. Already the machine just constructed by M. de Méritens is a considerable step taken in this direction, and I am justified in believing that this machine, which has already astonished those who have seen it at work, has not yet said its last word.

For us, who have from the outset watched the progress of these machines and who have ourselves contributed to the early improvements which were introduced into them, we regard with unfeigned pleasure the progress of this industry, which may be almost said to have been born in France. At the same time we must not forget that it is to the *Alliance* Company, and its clever engineer, M. J. Van Malderem, that we owe this magnificent application of electricity.

With this view, we think it will not be without interest to our readers to relate briefly the history of these machines.

In 1855, M. Nollet, a Belgian maker, constructed for electro-plating large magneto-electric machines on Clarke's system, which gave results of sufficient mportance to lead to the formation of a company who were to work them for the purpose of extracting gas from water. The idea was a foolish one, but for that very reason it found adherents, and it was this company which, under the name of the *Alliance* set up in 1855, in the buildings adjoining the Hotel des Invalides, the first large magneto-electric machines known in Europe.

Naturally the results were deplorable, and in 1856 the company was forced to liquidate.

It was re-organised later in 1856, and having appointed M. Berlioz its director, sought to avail themselves of some of the considerable plant which had been got together. It was at this time that I was consulted, and I pointed out to M. Berlioz the applications he could make of them to electric lighting and plating, but to this end many improvements had to be carried out in the machines, and every electrician of the period added a stone to the edifice.

Among these improvements, one suggested by M. Masson, who was at that time Professor of Physics at the Ecole Centrale and whom I had brought to see the machines, permitted an immediate doubling of the effects attained. It was to do away with the commutator, which had hitherto been employed in all these machines. These various improvements, admirably interpreted by M. Van Malderem conjointly with those he himself introduced, brought these machines to a state of perfection which one could scarcely have dared hope for at the first and which it was firmly believed it would be impossible to surpass. It was then that the idea was formed of making use of them for illuminating lighthouses and ships; experiments were commenced conjointly with MM. Reynaud and Degrand, and soon after, in 1863, the lighthouses of La Héve were lighted up in this manner.

At the same time experiments were made with a view to its application to navigation, but they did not meet with the success that might have been desired, principally by reason of the opposition offered by the Navy, although they gave results the importance of which was afterwards appreciated. It was France who preceded other nations in these two directions, as it is she who still leads them in public lighting. But we must admit that it is to the Alliance Company and to the courageous initiative taken by its intelligent director, M. Berlioz, that the civilised world owes these beautiful applications of electricity.

Having paid this tribute to a company whose efforts were not seconded by fortune, let us examine the further progress accomplished in later times.

The Alliance machine was a magneto-electric one, that is to say, composed of permanent magnets and induction coils. In its latest form it employed forty-eight magnets and four rollers each provided with ten induction coils; it gave reverse currents, and could feed three Jablochkoff candles; it required about three horse-power to drive it, and ran at a speed of 400 revolutions per minute. No heating took place in the machine, and the light given by it was very regular.

Under quite exceptional conditions this performance has been much increased, and a machine has even been spoken of which could feed six candles; the ordinary machines are, however, far from giving such results. But the machine we are about to speak of can, with eight magnets only (magnets of the same size as those of the Alliance), illuminate from three to four Jablochkoff candles, and it also gives reverse currents, which are rightly regarded as a favourable element in public lighting. It is true that the speed of this machine is greater, for it performs 700 turns per minute; but I am assured that it requires a motive force of only seventy-eight kilogramme-metres, *i.e.*, rather more than one horse-power, and experiences scarcely any heating. Its dimensions are very small, and its elementary parts are easy of adjustment and simple in construction.

The enhanced effect of this class of machine is due to the fact that to the induction currents produced in the coil of the Gramme machines are added those produced in ordinary magneto-electric machines.

In order to understand this, let us imagine a Gramme ring, fig. 5 divided for example into four sections, insulated magnetically the one from the other, and forming, consequently four electro-magnets placed end to end; let us suppose that the iron core of each of these sections is terminated at each end by a piece of iron A B, forming expanded prolongations of the poles; and let us suppose all these pieces to be joined by pieces of copper C D, to form one solid ring, around which are placed permanent magnets N S, with the poles alternating with each other.

Let us examine what will take place when this ring accomplishes a revolution upon itself, and let us see in the first place, what will happen on the approximation of the expanded pole B, as it travels from left to right, to the pole N. At this moment it will develope in the electro-magnetic helix an induced current, as in the Clarke machine. This current will be instantaneous, and in a contrary direction to the Amperian currents in the inducing magnet. It will be very powerful by reason of the proximity of B to the pole N; but the ring in passing on causes a series of magnetic displacements

between the pole N and the core A B, which give rise to a series of currents, which I call currents of polar interversion, from B to A. These currents will be direct in relation to those in N, but they are not instantaneous, and they increase in energy from B to A.

To these currents will be joined simultaneously the currents (of dynamic induction) resulting from the passage of the helix before the pole N. When A leaves N a demagnetisation current is produced, equal in energy and in the same direction as the magnetisation current due to the approximation of B to N. Thus we get reverse induced currents through the approach and recession of B and A; direct induced currents during the passage of the core A B before the inductor; direct induced currents resulting from the passage of the helix in front of N. All these inductive effects are thus accumulated in this combination; * * * * there are also currents resulting from lateral reaction of A B upon neighbouring poles.

To still further augment the effects of induction, M. de Méritens makes the core and appendages of thin plates of iron cut out as seen in the figure, and placed together to the number of fifty, each one millimetre thick. The coils are so arranged that they can be connected for tension, quantity, or in series.

In fig. 5 we have considered only four sections, but there are in fact more than this, the model to which we have referred possessing sixteen as shown in fig. 1. They are mounted on a bronze wheel centred on the motor shaft.

The inductor magnets, the poles of which are seen at A A', are placed above the wheel and strongly fixed horizontally to two bronze frames, as seen in figs. 2 and 3. A" shows the method of adjustment.

A little consideration will show that the ring is constructed under the best possible conditions. In fact, as each section is separate it may be dismounted singly, and consequently the wire can be wound on without difficulty. Those who know the difficulty of winding a Gramme ring will readily appreciate this advantage; on the other hand the core being composed of plates which can be at once removed by releasing the key-piece is an enormous advantage, for it obviates the precision necessary to the construction of solid rings, which are always difficult to keep perfectly true. Lastly, there is neither commutator nor collector, and consequently no loss of current.

Figs. 2 and 3 represent a vertical section, and the details of construction, which will be understood without further description.

We have said that this machine can feed three or four Jablochkoff candles applied to an electric light regulator; but it has also been found competent to illuminate regulators, even when the carbons were separated by a distance of three and a half centimetres. It is certain that these results are very important, and one may safely augur a future for this machine. All who were present at the experiments were astounded.

These machines are ably constructed by MM. Chardin and Cerjot, assisted by M. Maurin.—*L'Electricité.*

[We are indebted to the editor of *L'Electricité* for the blocks wherewith to illustrate this article.—ED. T. J.]

NEW PORTABLE BATTERIES.

M. BEAUFILS' BATTERY:—A new feature, which is likely to be of considerable importance in the manufacture of batteries henceforth, has recently been introduced by M. Beaufils, a chemist of the French Telegraph Administration, Paris. It consists in forming the depolarising salt into a solid conglomerate, a form which has many advantages in point of portability, cleanliness, and economy. M. Beaufils has applied his idea of conglomerate depolarisers to the Marie-Davy sulphate mercury battery, and the result is a superior and very lasting portable pile, which cannot fail to be of great service in military and domestic as well as civic telegraphy. The larger forms of this battery are in use on the French Telegraph service, and have, we believe, given very good results. Figure 1 represents in full size, one of the smaller types, designed for medical purposes. It consists of a

FIG. 1

vulcanite vessel V; a zinc plate Z; a carbon plate C, to which is attached a slab of powdered carbon and sulphate of mercury conglomerate. The conglomerate and zinc plate are separated by a piece of sponge S, wet with water. Electrodes are connected to the poles. To charge this cell, or any of the other forms of the conglomerate battery, it is only necessary to damp the sponge, or add clean water. One of these cells will work for years without any attendance. The electro-motive force is that of the Marie-Davy battery.

We may add that the makers of the Leclanché battery, recognising the importance of the conglomerate principle, have adopted it in the manufacture of the latest Leclanché cells.

M. GAIFFES' BATTERY:—Is a chloride of silver element designed for medical purposes. Fig. 2

represents the internal arrangement of the plates ; z is the zinc plate; s the silver plate, a paddle shaped slab of silver; and P is a bed of bibulous paper intervening between the zinc and silver plates ; E is the cover of the cell, an ebonite top carrying the terminals ; and R is a clasp of ebonite, or an india rubber band, to hold the plates together. In order to change the cell it is only necessary to moisten the bibulous paper with a solution of chloride of silver in water. The cap fits tight to the top of the vessel, which is also of ebonite, and thus prevents evaporation.

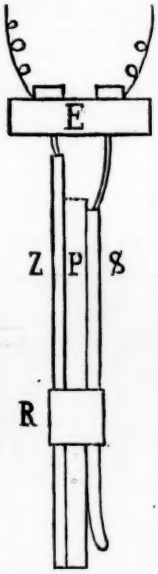


FIG. 2.

We have recently called attention to the advantages of the chloride of silver cell as a constant battery, especially for testing purposes, and we would now suggest that experiments should be made with a view to forming a solid conglomerate of the chloride of silver, on M. Beaufils' principle, so as to increase the portability and serviceableness of this cell.

THE RONALDS' LIBRARY AND CATALOGUE.

By ALFRED J. FROST, Acting Librarian of the Society of Telegraph Engineers.

AT the Conference of Librarians, held in London last year, the writer briefly called attention to the fact that the Society of Telegraph Engineers was preparing for publication a complete catalogue of the literature relating to electricity and magnetism, and the cognate sciences. The catalogue referred to (which has been edited by the writer) was compiled by the late Sir Francis Ronalds, F.R.S., who devoted the greater part of a long life to its completion, and to the formation of a valuable library bearing his name, now in the possession of the Society of Telegraph Engineers.

Sir Francis Ronalds, who became one of the earliest members of the Society, died in 1873, bequeathing the library to his brother-in-law, Samuel Carter, Esq.; and this gentleman, in accordance with the wishes of the testator that the library should be made available for students of electricity, handed the same over to the Society upon certain conditions, one being that the Society should bear the cost of printing the catalogue, which it had been the labour of its author's life to complete. The Society, although a very young one, willingly undertook the charge, and has spared no expense in making it worthy of its author, and of its importance in relation to science and bibliography.

The catalogue contains upwards of 12,000 entries, and is believed to contain a record of nearly all the important books and papers bearing on the subject, published in any language, up to within a short time of its author's death.

In the compilation of the catalogue, Sir Francis Ronalds adopted what is now known as the card system, thus using a separate slip for each entry. I am not aware who introduced this system, or the date of its introduction, but inasmuch as the catalogue referred to was commenced probably as early as 1820, I think Sir Francis Ronalds may be numbered amongst the earliest to see the advantages which that system bears over many others, especially in the compilation of a catalogue where many of the books are not seen, but have their titles, &c., copied from other sources. Every slip in the catalogue shows upon its face the whole history of the record. For example, in many instances it is found that the first notice of a work was obtained from some author's reference; later on—perhaps years—some further information is obtained of the work in, probably, an old bookseller's catalogue, the slip is looked up and the further particulars are added, the source of the information being given in every case; later on again, perhaps a further reference to the work is found in the catalogue of some public library, in which case any further information thus obtained is added to the slip, and lastly the book itself finds its way into the library, when all doubt as to accuracy of the entry is at an end, as the actual title is then examined with the slip, and any particulars which have been omitted are inserted. Another advantage of using a slip for each entry is the facility given for making notes. Had the titles been entered into a book it would have been very difficult, and almost impossible, to have added so much from time to time, as it was found necessary to do, in the work now referred to.

It was considered desirable to preserve as many of the author's notes and references as possible, and these notes will form quite a special feature in the catalogue, besides which there will be found after most of the important names a reference to the date and place of birth, and when possible the date and place of death of the author. Although this information is not usually given in printed catalogues, it was thought that it would not detract from its value, if inserted, but would, on the contrary, enhance its importance, and render the work more valuable as a book of reference.

The publishing committee of the society gave considerable attention to the type most suitable, and it was decided to adopt large Clarendon type for the authors names; all notes, references, &c., otherwise than the actual titles, being printed in italics; special prominence has been given to dates. The books actually in the library are designated with a dagger.

Although the catalogue professes to relate simply to electricity and magnetism and their applications, it will be found a most valuable record of scientific books generally, inasmuch as almost all books treating of Natural Philosophy and Physical Science, contains something electrical, and it was of course necessary to include all such books in a work of this nature.

The catalogue will be published at a price much less than its cost, and it is proposed to issue to subscribers a separate Librarians Edition, printed on one side of the paper only, the price of which will be 20s., the price of the catalogue in the ordinary form being fixed at 16s.

The library formed by Sir Francis Ronalds, above referred to, contains about 10,000 works, a large number of which consist of the electrical papers cut from the philosophical transactions of the Royal Society, and from the transactions and proceedings of other English and foreign public societies, and from scientific periodicals, &c. The collection is a very complete one, particularly in Italian, French, and German, and may almost be said to be unique.

Sir Francis Ronalds has been long known to the scientific world as the author of a small and now scarce book, the first ever published on the subject of the Electric Telegraph.*

This book describes a system of Electric Telegraphy, which its author invented and worked as early as 1816. The invention was a perfectly practicable one, and has gained for its author, from more than one learned authority, the title of "The father of Telegraphy." The invention, however, was produced some thirty years before the world was prepared for it, as is shown by the reply of the Secretary of the Admiralty in dismissing an application which had been submitted to him. It was as follows:—

"Mr. Barrow presents his compliments to Mr. Ronalds, and acquaints him with reference to his note of the 3rd instant that telegraphs of any kind are wholly unnecessary, and that no other than the one now in use will be adopted. 5th August, 1816."†

The result was that the telegraph remained nothing more than a successful experiment. Sir Francis Ronalds was, from his scientific attainments, and from his knowledge of foreign languages, well fitted for the task he set himself, and it is very much to be regretted that he did not live to see his work issued from the press. He received the honour of knighthood about three years before his death in recognition of his early contributions to electrical science.

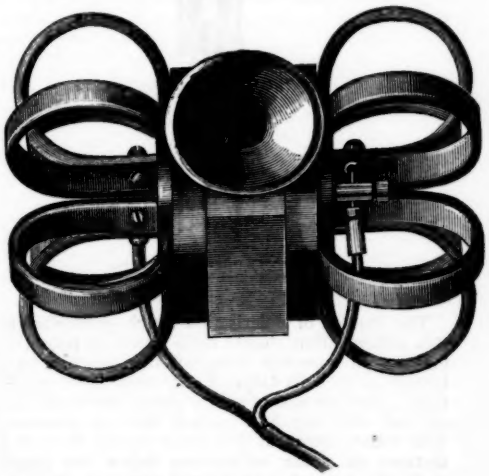
In conclusion it may be added that owing to the fact that most of the books and pamphlets are in an unbound condition, the library has not yet been opened for reference. The binding will, however, be quickly proceeded with, when the library will, under certain conditions, be opened to students and those interested in the subject to which the collection refers.

* Descriptions of an Electrical Telegraph, and of some other Electrical Apparatus. By Francis Ronalds. 8vo. London, 1823.

† Journal Society Telegraph Engineers, Vol. IV., p. 5, 1875.

PHELPS' "CROWN TELEPHONE."

THE figure illustrates the double form of Mr. Phelps' Crown Telephone, which is used in America in conjunction with Edison's Carbon Telephone. It consists of two magneto-electric crown telephones united. Each of these consist of a coil, diaphragm of iron, and six permanent magnets. The six magnets are placed with their like poles together in the centre of the coil, the other poles being bent round, as shewn, into contact with the periphery of the diagram. Thus the diaphragm forms the other



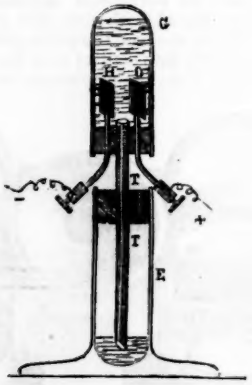
pole to that within the coil, and in this way the magnetic field is intensified. In the double crown form, the two diaphragms are separated by a cavity, or air-chamber, with a mouthpiece or orifice, into which the person speaks. The coils are so connected in circuit that the vocal currents generated in each coil strengthen one another. In a recent trial of this instrument at Dr. Well's church, Brooklyn, New York, with Edison's carbon transmitter, an audience of three hundred persons distinctly heard speaking and music, both vocal and instrumental, in every part of the hall.

BERTIN'S EXPLODING VOLTAMETER.

THIS little known experiment is very interesting, in that it makes apparent certain phenomena of polarisation of the plates of an electrolyte which are ordinarily produced under different conditions. The instrument constructed by M. Ducretis, and of which a figure is given, is composed of an inverted bell G, closed by a cork, through which are inserted two platinum wires, terminated by large

electrodes, H and O. This arrangement is supported by a glass tube T, open at its two extremities, and fixed in the cork of a glass vessel E. Two terminals + and — serve to connect the platinum wires with a powerful battery (50 Bunsen cells).

The bell G being filled about one-tenth full with acidulated water, the battery is connected to the apparatus, and the decomposition of the liquid which results, forces the latter out of the bell into the vessel E, and when the bell is almost full of gas, the mixture explodes spontaneously, and the bell is illuminated. This experiment is without danger, the recomposition of the products of the electrolysis taking place spontaneously, and during the passage of the current.



The current of polarisation which gives place to this inflammation should have a certain potential, for the phenomenon does not take place with a battery of 30 cells only. Under these latter conditions a phenomenon of another kind, and hardly less curious than the first named, may be observed. The water, which at first sinks rapidly in G to a distance of some millimetres below the plates, suddenly stops, in spite of the disengagement of gas which takes place from the portion of the wires below the plates. With well water the decomposition of the water is less rapid, and the explosion is not produced even with 50 Bunsen cells. But another curious phenomenon is observed. The water sinks down to the base of the plates, and at that moment commences to rise again, and this oscillation is continuous, the water being alternately decomposed and recomposed. A current of less strength than 30 cells effects decomposition only. These phenomena are entirely due to the polarisation of the electrodes, and not to the catalytic force of the platinum, for the same results may be obtained with electrodes formed of other metals.—*L'Electricité.*

THE THERMOPHONE.

By THEODOR WIESENDANGER.

THE deficiency in intensity of the sound produced in the ordinary telephone has been considered to be due to magneto-action. For this reason, scientific men have thought it expedient to advise inventors to abandon the known principles, and, if possible, to open a new route of progress in telephony.

I have devoted a great amount of time and much effort to this end, and have obtained some interesting results. In looking for a new source of sound for the telephone, I directed my attention to *(a)* the sonorous vibrations produced by the expansion of bodies under the influence of heat, and *(b)* to the production of heat by means of the electric current.

Whenever a quantity current is sent through a circuit consisting of two stout copper wires, to whose extremities are attached the ends of a bad conductor, say a short piece of thin platinum wire, the latter immediately becomes red hot, and, if the current be powerful enough, it instantaneously fuses. It should be remembered that no appreciable amount of time is required for this action. Sulphide of copper is known to develope so much heat under these conditions as to form the prime element of an efficient electric fuse. Gas carbon and other bodies of low conductivity show the same results. The resistance thus interposed converts a portion of the electric current into heat. As bodies are known to expand when subjected to a higher temperature, the platinum wire, or gas carbon, or sulphide of copper, &c., will increase in length, width, and height, and thereby produce a condensation in air. (I would point out here that soft iron or steel under the influence of electro-magnetic induction only increase in one dimension.) When the above-named substance cools it contracts, and must cause in the surrounding air a rarefaction to a corresponding degree. When these impulses re-occur periodically in rapid and regular succession, they produce on the human ear the impression of sound.

While experimenting on this subject, I employed an electro-magnet, whose coil consisted of a tubular piece of inferior iron, the coil of copper wire (No. 26). I noticed, with interest that, under the influence of powerful currents, produced by the battery of my "music telephone," the magnet in a short time became appreciably heated. Iron of inferior quality is very intolerant to electro-magnetism, and this resistance to induction produced the heat. I thought, then, to have discovered here a means of intensifying the effects above described by utilising as a source of heat not only the resistance of a bad conductor to the passage of the electric current, but also the resistance offered by iron or steel to electro-magnetic action, the energy inadequately termed "coercive force." Direct electro-magnetic action has been employed in our instruments to a limited extent only. The combined effects of these three kinds of impulses produce what, until now, was vaguely called "molecular vibration." The bad conductors I interpose in my instruments are small coils of very thin insulated wire of German silver, platinum, or copper. The sounds emitted by these coils are quite distinct, but very faint, and I intensified them by adding the effects of the resistance of coercive force to electro-magnetic induction, and also by producing these sounds on resonant surfaces or cavities. By these means I succeeded in constructing very efficient receivers without the use of magnets proper. One of these instruments, fig. 1, is of the following construction.

Three discs of thin charcoal iron, one $\frac{3}{4}$in. diameter, the other two of 3in. diameter, are varnished on both sides and afterwards glued together, the smaller disc between the centres of the two larger ones. A very thin reel *e f*, is thus formed, and on it is wound a coil of about five to ten yards only of silk-covered copper wire, No. 36.

This reel is then glued on the centre of a thin membrane, *b c*, stretched over one end of a brass tube A, 4in. long, $3\frac{1}{2}$in. in diameter.

Another receiver is constructed, as shewn by fig. 2 :—A tube of tinned iron, *c d*, 6in. long, $\frac{3}{4}$in. in diameter, is soldered in one spot only (not all round) to the centre of an ordinary Bell's telephone

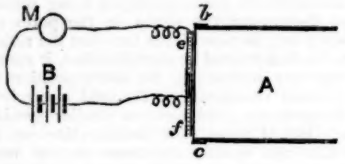


Fig. 1.

disc *a b*, mounted on a stand. A coil, *e f* such as described above, or longer, is wound round the tube in close proximity to the disc. This disc and tube combined prove to be an excellent resonator. I find it as delicate to sonorous vibrations as the acoustic telephone with the string kept tight. With this receiver I hear the tune of a musical box and speech reproduced with great fidelity in quality as well as in pitch, and with considerable intensity. A tube of tinned iron, 3in. long, and $\frac{3}{4}$in. in diameter, wound with a small coil of insulated wire, will reproduce telephonic sounds.

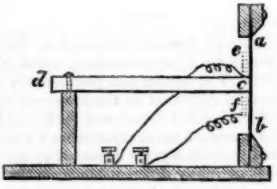


Fig. 2.

In both cases a battery B, and ordinary microphonic transmitter M, are connected in the circuit.

Fig. 3 represents a form of thermophone where the bad conductor interposed is a long and thin rod of gas carbon or plumbago. In this arrangement *a b* is an ordinary Bell telephone disc, *c d* a spring, *f g* a carbon rod, *h* a spring support, *k* a spring for adjustment, and *l* an adjusting screw. The carbon rod resting on a spring support, can be made to bear with different amounts of pressure on the centre of the disc by means of the adjusting screw. This instrument acts well as a receiver after the exact adjustment has been experimentally determined, an operation which sometimes involves much time and patience. It need hardly be mentioned here that the same instrument forms an efficient transmitter.

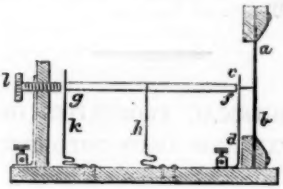


Fig. 3.

These instruments forcibly demonstrate that neither disc nor magnet are essential portions, but only accessories of a telephone receiver, and their performance cannot leave any doubt as to the correctness of the theory we expound.

Nevertheless, I must expect adverse criticism on my explanation of the action of these instruments. The principal theoretic argument brought against me, will be that a succession of changes of temperature so infinitely rapid as to produce sound by the expansion of the bodies acted upon is an impossibility. But exactly the same argument was used against the rapidity of electro-magnetic changes until the performance of Professor Bell's telephones vanquished the rash hypothesis.

I would refer those who entertain any doubts to experimental verification of these facts, and ask them to wind *one* yard only of insulated wire around an ordinary steel spool of a sewing machine, to include that miniature coil together with a strong battery in an electric circuit, and to make and break contact very rapidly. The results thus obtained will be a more convincing proof than any assertions I can make in writing.

While engaged in active research on these receivers, I heard reports on Mr. Blythe's and Mr. Hughes' microphone receivers ; and it struck me then that the principle of action of these instruments was exactly the one I was experimenting upon. The carbon, as an inferior conductor, offers a considerable resistance to the passage of the electric current, its temperature is raised in degrees corresponding with the intensities of the currents sent, and it will expand by heat in degrees corresponding with the undulations of the current as produced or varied in the transmitter by sonorous vibrations of different amplitudes.

I was struck not to hear of any successful repetitions of Mr. Blythe's experiments. The principle of action evidently had not been understood, and experimenters, instead of using quantity currents, employed the usual microphone batteries, which are, of course, exceedingly weak, and whose currents only produce minimum effects of the nature described.

The principle I have explained allows of a great many different applications. I have produced a variety of receivers ; none are so perfect as I could wish, nor even so efficient as a good "Bell's telephone ;" but

no doubt, inventors and other students in telephony will take up the work and experimentally develope it further. So far, I feel satisfied in having discoved the principle and experimentally established the possibility of reproducing sounds by thermo-action, through conversion of forces. A new route is thus opened to scientific research, and to progress in telephony.

THE ELECTRICAL PROPERTIES OF BEES WAX AND LEAD CHLORIDE.

By Professors J. PERRY and W. E. AYRTON.

Abstract of Paper read before Section A of the British Association, August, 1878.

PROFESSOR AYRTON commenced by noting the close way in which investigations in the various branches of physical science were linked one with another, and by remarking that experiments on electric absorption ought to have no less interest for the scientific engineer than those on the increasing strain of materials under constant mechanical stress had for the electrician. He next explained how, in consequence of the absorbed charge in water being immeasurably greater than the surface charge, the direct method of determining experimentally the specific inductive capacity employed by Mr. Perry and himself, in their experiments on "Ice as an Electrolyte," failed to give the result equal to the square of the index of refraction for light of infinitely long waves, and he suggested that the method recently employed by Mr. Gordon for measuring the specific inductive capacity of solids with very rapidly reversed charges might possibly, if applied to water, give an answer approximately more equal to the square of the index of refraction; however, he was inclined to think that, since Mr. Gordon's method for solids gave (after the application of the proper correcting factor for the thickness of the dielectric) numbers closely agreeing with the received specific inductive capacities, there existed no known method for correctly ascertaining the electric capacity of a liquid.

For although a condenser might be made of opposed metallic plates separated by a space almost entirely filled with a liquid dielectric, which did not, however, touch either plate, and although, according to the ordinary nomenclature, the two plates in such an arrangement would be said to be insulated from the water and from one another, still, as explained in their paper on the "Viscosity of Dielectrics," a succession of rapidly reversed charges would be accompanied by *true electric conduction;* in fact that it would be well worthy of consideration whether the explanation of the result which Mr. Gordon had brought to their notice at this meeting, viz.: that his new method of measuring specific inductive capacity of solid dielectrics had given the old results might not be found to consist in this *conduction*—this viscous conduction he might term it, although in reality there was but one kind of conduction, the conversion of electric energy into heat—for this conduction would occur unequally in the two apparently balanced condensers, since the two dielectrics varied in viscosity, consequently the balance of capacities was not a real one.

Nevertheless Professor Ayrton thought it highly important that careful experiments should be made, both with constant and with rapidly reversed charges, on the inductive phenomena observed in such a water condenser as he had described.

The abnormal rise in the specific inductive capacity of bees' wax, on solidifying, which the experiments of Professor Perry and himself had shown, coincided with an increase in the index of refraction; he regarded this as furnishing an important addition to the experimental proof of Professor Clerk-Maxwell's electro-magnetic theory of light, and he hoped that some of those philosophers of Trinity College, Dublin, who had so successfully turned their attention to the elucidation of the molecular vibrations causing Crookes' force, would give their views on the molecular vibrations accompanying wave motion and electric induction.

He thought that the experiments described in the paper on bees' wax and lead chloride showed, in a sufficiently satisfactory way, that, where the resistance of an electrolyte diminished by electrification, it was due to the electromotive force employed being sufficiently great to decompose the damp in the pores of the electrolyte; but, in view of the fact that the resistance of water itself increased by electrification, it seemed to follow that the products of the decomposition of the damp must act chemically on the solid electrolyte and cause deterioration, and hence a smaller specific resistance. But if there were deterioration we should expect that the specific resistance of the material would steadily diminish day by day, a result that was not obtained in the experiments of Professor Perry and himself, on bees' wax at any rate, as will be seen on examining the table given in the paper in the *Philosophical Magazine* for August. He therefore concluded that further experiments on electrolytes, in which resistance diminishes by electrification, were necessary to make the explanation quite complete.

NEW MAGNETIC FIGURES.

By SILVANUS P. THOMPSON, B.A., D.Sc., Professor of Experimental Physics in University College, Bristol.

Abstract of Paper read before Section A of the British Association, August 19th, 1878.

THE author desires to draw the attention of the Section to the series of magnetic figures exhibited, which has recently been completed. The figures are permanently secured on glass by a process described in recent communications to the Physical Societies of London and Paris; and they have also been photographed as transparencies for the lantern.

It is believed that the figures assumed by iron filings in magnetic fields of many different kinds, in the series now produced, will be found of great use in the study and teaching of known laws of magnetic and electro-dynamic action, and also in the experimental determination of the action of magneto-dynamic and electro-dynamic systems and machines. Faraday discovered that the lines of force traced out thus by iron filings possessed a significance hitherto disregarded, and revealed indeed the very seat of the attractions and repulsions taking place between magnetic bodies. The method had indeed been imperfectly employed by Musschenbrock at an earlier date, but it only became really fruitful in the hands of Faraday. The author has applied Faraday's reasoning to the figures produced by electric currents traversing conductors in various circumstances, and finds that from the figures alone nearly all the recognised electro-dynamic, magneto-dynamic, and magneto-electric relations can be deduced, or verified.

The series of figures now presented illustrate amongst other matters the following actions:

(1.) The attraction (or repulsion) of magnets by magnets.
(2.) The attraction (or repulsion) of currents by currents.
(3.) The attraction (or repulsion) of magnets by currents.
(4.) The rotation of magnets by currents.
(5.) The rotation of currents by magnets.
(6.) The rotation of a magnet round its own axis under the influence of a current.
(7.) The repulsion by a current of its own parts.
(8.) The mutual inductive action of solenoids and magnets, and of magnets and magnetic matter.
(9.) The flow of currents in conductors and conducting media.
(10.) The action on magnets of magnetic media.
(11.) The action of magnetic instruments, magnetometer, galvanometer, electro-dynamometer.
(12.) The action of magneto-electric machines.
(13.) The magnetic properties of cobalt and nickel.

The figure illustrative of the lines of force surrounding a current has been previously given by Faraday, Guthrie, and Barrett. Those illustrative of the attraction and repulsion of parallel currents, by Faraday, but imperfectly. Those illustrative of flow of currents in conductors by Kirchhoff, Guthrie, and Carey Foster and Lodge.

Those illustrating the action of the galvanometer and the Gramme machine were suggested to me respectively by Mr. C. W. Cooke, and Mons. A. Niaudet.

The photographs have been executed directly from the filing figures by Mr. Robt. Gillo, of Bridgwater, of the firm of F. York & Co., of Notting Hill, the eminent manufacturer of photographic transparencies for the lantern.

ON LIGHTNING CONDUCTORS AND ACCIDENTS BY LIGHTNING.

By RICHARD ANDERSON, F.C.S., Member of the Society of Telegraph Engineers.

Abstract of Paper read before Section A of the British Association, August, 1878.

AT the present time at least one-half of all the public buildings, including the churches and chapels, of Great Britain and Ireland are without protection against lightning. As to private houses, it is safe to assert that not five out of every hundred have lightning conductors.

According to the reports of the Registrar-General, the number of deaths from lightning in England and Wales during the eight years from 1869 to 1876 reached a total of 182.

According to the report of Dr. Engel, Director of the Statistical Bureau of Berlin, the number of lives lost during the same period in Prussia was 819.

The terrible losses, both of property and human lives occasioned by lightning, are mainly due to three causes, namely: first, in not providing any lightning conductors at all; secondly, in not placing them in the right position, or in sufficient number to cover a given area; and, thirdly, in not having them regularly tested, so as to ascertain their constant efficiency. Even some of the first cathedrals of England, such as Peterborough, have no lightning conductors whatever, while others, supplied with them, Windsor Castle for example, are insufficiently protected, as is apparent to any competent observer.

If the entire absence of lightning conductors is the most prevailing cause of the still exceedingly great number of casualties occasioned by lightning, that of ill-placed or insufficient conductors is another deserving much attention. The mischief done in this case is not only that the conductor gives a false security, but that, should the dwelling on which it is placed be struck by lightning, it leads to the belief that the wonderful scientific discovery of Franklin is nugatory, or at least uncertain in its action. A case of the most instructive kind, in which a house with a proper conductor fixed on it was struck and damaged by lightning, came under my own observation quite recently; a heavy thunderstorm passed over it, and the electric discharge fell on one of the towers, knocking down part of a crenellated wall, not more than three yards from a lightning conductor, and then passing off without doing further damage. The conductor being new and in good order, it seemed at first sight a very extraordinary case; but the mystery of it was soon explained by an examination of the premises, which I undertook. I found that the roof of the tower on which the lightning fell was covered by a solid mass of lead, of unusual thickness, connected at one end with a large iron water-pipe about four inches in diameter. In this case the electric force, to get to this rival conductor, heavier in metal than the one designed for the purpose, and therefore offering the best road earthward, had to smite the brick wall in its way, and having done this, it went down the iron water-pipe into the ground, doing, as already mentioned, no more damage. Had the actual conductor either been larger, that is, heavier in metal than it actually was, or had it been connected with the mass of lead in the first instance, the lightning could never have struck the house. The incident forcibly illustrates the necessity of leaving the design and erection of lightning conductors to no others but those who have made a thorough study of the subject, since the work is not by any means so free from complexity as is commonly believed.

The third cause is the utter neglect of the conductor, when once it has been put in its place; other repairs to all sorts of public buildings are regularly executed, but the lightning conductor is taken no notice of and is never tested.

Having drawn attention to the chief causes of the numerous and fatal casualties caused every year by lightning, I have only to add a few words of advice as to how they might be prevented, or at least greatly diminished. First of all, I think it most desirable that public recommendation should be made, by local and other authorities, to place lightning conductors on all exposed or high-lying buildings, whether public or private, as well as on those standing near woods and on moist ground. It might be well worth the trifling expense to place simple conductors also against trees in parks, under which there are benches, or where persons are likely to gather during a thunderstorm, they forming a prolific source of fatal accidents. Above all, no church, chapel, school, prison, or other large public building, ought to be without one or more lightning conductors. But if it is necessary to greatly multiply lightning conductors, it is equally so that they should be planned, erected, and also periodically tested by competent persons, with scientific as well as practical knowledge of the work. The testing should take place at regular intervals, perhaps best in the spring, before the advent of the summerly thunderstorms, and it should likewise be made whenever a building has been undergoing repairs which may have damaged the conductor. To show the importance of constantly testing even the best laid conductors, I can cite another instructive case where a house was apparently well protected. On the 19th of August, 1876, shortly before midnight, a heavy stroke of lightning fell upon a mansion near Kew Bridge, Middlesex. The electric force destroyed the top of a large chimney, knocking off part of the coping, not more than two or three feet from a lightning conductor, to which it then flew, making its way down to the earth, but not without causing the greatest disturbance all along its path—lifting up, among others, some heavy marble toilet tables in bed-rooms some six feet distant on either

side from the copper rope, which under ordinary circumstances, would have carried the electric force noiselessly, as well as harmlessly, to the ground. The fact of this disturbance indicated at once the source of the mischief. The lightning conductor, good as it otherwise was, had no sufficient earth connection. It went into the earth, it is true, but into soil altogether dry, and therefore the conductor did not, and could not, act properly. Nothing was wanting in this case for protection against lightning but regular testing, in default of which it can never be known whether a conductor is actually efficient at any time. A well organised system of inspection of lightning conductors would be most inexpensive. The galvanometer used for the purpose has been latterly much improved in Germany, and small portable instruments, of the size of a diminutive carpet bag, are now made, which leave nothing to be desired in the shape both of effectiveness and durability. Already such a system of inspection and testing of conductors exists in Paris and several other French towns. Shall we say, once again, "They manage these things better in France?"

Correspondence.

THE THEORY OF THE MICROPHONE.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—In my letter of the 10th, which you were good enough to insert, I made reference to some experiments with the microphone, which I undertook with a view to ascertain the nature and action of Professor Hughes' discovery, and which have led me to form an opinion at variance with that of the molecular distention theory given by Mr. Hughes.

It is difficult to comprehend that vibratory motion can cause molecular expansion, if this were true. The carbon should become specifically lighter whilst undergoing vibratory movement. I am not aware that such is the fact. Professor Hughes assumes that the carbon pencil elongates under vibration, and so alters the pressure of contact, the resistance of which varies with the rise and fall of the acoustic wave.

Having employed a Riess's transmitting apparatus to open and close a primary circuit of an induction coil, the secondary of which was connected to the line wire, I succeeded in growling out the tune of "God Save the Queen." The receiver very considerably augmented the loudness of the original, but articulation was not arrived at.

What, then, is the difference between two platinum and two carbon contacts.

Or, why does Riess's transmitter fail to articulate while Professor Hughes' does this very perfectly?

In the platinum contact-maker you do not obtain sound until the amplitude of the sonorous vibrations is sufficient to interrupt the circuit, and as a consequence, a bright and explosive arc is the result. It is this little explosion that produces the jarring sound which I have described as a growl.

Mr. Teutes, of Dublin, succeeded in obtaining articulation with a Riess transmitter by simply moistening the platinum contacts to prevent the entire disruption of the circuit whilst the contact-maker was vibrating. Imagining some such cause to be at work in the microphone, I devised a plan to examine the nature of the circuit by bringing the two contact points of the microphone carbons under view of a powerful microscope.

The microphone, which was of the hammer and anvil construction, I placed near the end of a light lath, the other end of the lath being fixed to a sounding board maintained in a state of vibration by means of a tuning fork.

Whilst the tuning fork vibrated, a clear space was visible between the carbon contacts by aid of the microscope, the magnifying power of which was about 350 times.

I then connected the leading wires from the microphone to a battery of 4 volts tension; the circuit I could open or close at pleasure by a little tapper key.

Each time the key was pressed a gray cloud traversed from carbon to carbon, the cloud being most dense at the time of closing the circuit. This, then, explains the action of the microphone; the carbon may be regarded as an aggregation of conducting particles, which become, under vibration and attrition, loosened at the contact points, in the form of very minute powder, so impalpably fine as to defy microscopic definition, escaping as a cloud darkening the field of view, and may be regarded as a conducting vapour which maintains the circuit. The approach or the recession of the contact points shortens or lengthens the conducting column, reducing or augmenting the resistance in the circuit, and thus makes the electric and sonorous waves sympathetic.

Yours, very truly,
Sept. 23, 1878. FREDK. H. VARLEY.

To the Editor of THE TELEGRAPHIC JOURNAL.

Sir,—On page 71, *Telegraphic Journal*, for February 15, 1878, there is an appalling formula for localising a partial disconnection in a submarine cable when there is an earth current in it. The formula is rendered very obscure by the way in which it is printed. A portion of the second term of the right hand number of the equality is under the symbol for extracting the square root, and the remainder, which is below it, looks like a multiplier of this portion. The latter is intended for a continuation of the second term under the symbol, which is a fraction, but whether the continuation, also a fraction, belongs to the numerator of the former, or whether the two numerators and the two denominators are both continuous is not evident. The author works out his example on the second assumption, and *by halving the first term under the square root symbol* arrives at a very happy result. But if the formula is correct, $R = -1047$, from which we may surmise that the fault is "on the other side of Jordan."

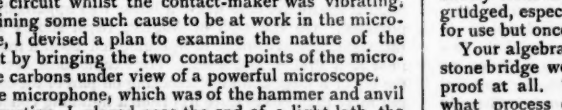
Yours truly,
H. A. W. FANSHAWE.

[The formula you refer to should be as follows:—

$$R = \frac{L_1 + L}{2} - \sqrt{\frac{(L_1 + L)^2}{4} - \frac{3\,Q_2\,L}{3\,Q_1\,(L_1 - L)} \cdot \frac{n\,(G + L_1)}{n\,(G + L_1) + G - \rho}(G + L)\,(\rho + L_1) - L^2\,Q_1}$$

The numerical example, which was given, is perfectly correct. With reference to the "appalling" nature of the formula, we must remark that it is so only in your imagination, as when the numerical values of each of the quantities are obtained, ten minutes at the most would suffice to work out the value of R (at least, for anyone of ordinary intellectual capacity), and we can hardly believe that that amount of time would be grudged, especially when the formula may be required for use but once in the course of a year.

Your algebraical proof of the principle of the Wheatstone bridge we must confess, does not appear to be a proof at all. To commence with, it is not evident by what process of reasoning you obtain the equality $A = \frac{b}{a+b} F$; but granting that this and the equations $B = \frac{a}{a+b} F$ and $\frac{G_1}{G_2} = \frac{AC}{BD}$ are correct, it seems to us that



these, when $G_1 = G_2$, are quite sufficient to prove the truth of the equation $ad = bc$, without the other equations which follow. Perhaps, however, we have misunderstood your explanation.—EDIT. TEL. JOUR.]

J. BROWN.—Articles and notes on Electric Light &c., will be found in the pages of this Journal as follows:—June 1, May 15, November 1, December 15, 1877; January 1 and 15, April 15, May 15, June 1, and July 15, 1878. Gramme's Machines, January 15, February 15, 1873; September 15, 1874; January 1, August 15, September 1, October 1, 1875; December 15, 1876, September 1, 1876; August 15, 1877. Breguet's Machine, April 1, 1876. Siemens' Machine and Lamp, November 15, December 1, 1877; Varley's Electro-Static Multiplier, May 1, 1878. Lodyghin and Kosloff Lamp, May 15, 1874; October 15, 1877. Jablochkoff Lamp, November 15, 1876; May 1, 1877. Rapieff Lamp, August 15 and September 1, 1878. Regnier Lamp, February 1, 1878.

Reviews.

Posts and Telegraphs, Past and Present; with an account of the Telephone and Phonograph. By WILLIAM TEGG, F.R.H.S. W. Tegg & Co., Pancras-lane, Cheapside.

MR. TEGG, the well-known publisher, is the author of several entertaining and instructive volumes, such as *Meetings and Greetings of all Nations*, *One Hour's Reading*, &c. They are characterised by a genial style, a sense of humour, and, at the same time, a strict accuracy and a power of seizing upon the most salient and instructive points of the subject in hand. The present work is no exception to the rule. It is designed for the general public, to acquaint them with the origin and history of the letter and telegram posts in this country, and, indeed, in the world. A happy thought on Mr. Tegg's part, for although everyone uses the post and the telegraph nowadays, it is remarkable how few understand either how they have arisen or how they are carried on. This is especially the case with the telegraph, and Mr. Tegg's handsome little book should enlighten them upon the subject in a light and readable form. Although the book is enlivened by annecdotes and a touch of fancy here and there, it must not be supposed that it is ever trivial, or sacrifices accuracy to sensation. It is not intended to be a scientific book, or a book for the specialist, yet it is a book which the telegraphist and professional electrician may read with pleasure and profit, for it contains a connected history of the postal and telegraph sevice and their operation, with some acount of the Atlantic cables. The telephone and phonograph are added for the benefit of the general readers.

Lightning Flashes and Electric Dashes. A volume of choice telegraphic literature, humour, fun, wit, and wisdom. Compiled by W. J. JOHNSTON, Editor of the *Operator*, &c.

Lightning Flashes and Electric Dashes is the rythmical title of a contribution to telegraphic romance, now well known on the other side of the Atlantic. We have been told by Mr. W. H. Preece how popular the telegraph service is in America, and the appearance of a new edition of this book is pleasing evidence of the fact, for it is read not only by American operators (who, we must say, are fired by a praiseworthy zeal for their calling, which is refreshing to see), but by the general public also. It is always interesting to look over a literary novelty such as this is, in order to discover if it contain any traces of true merit, any grains of gold among the dross; and we have been gratified in finding that our quest here was not in vain. *Lightning Flashes* contains some miscellaneous samples of considerable native literary power. The best writers are Mr. W. P. Phillips, or "John Oakum," the author of "Oakum Pickings," Charles Barnard, Miss Schofield, the young Canadian lady operator who recently in a fit of insanity precipitated herself over Niagara Falls, and Mr. J. M. Maclachlan, a superintendent of our own telegraph service, St. Martin's-le-Grand. Most of the pieces have been republished by Mr. W. J. Johnston from the *Operator* journal. The book is illustrated by cartoons of Mr. J. J. Calahan and others. While upon this subject, we may mention that a new story, entitled "Sam Johnson; the Life and Experience of a Railroad Telegraph Operator," by Mr. J. A. Clippinger, one of the contributors to *Lightning Flashes*, is about to appear in America. The insight which writings of this kind gives into telegraph life in America should render them of additional interest to the fraternity in England. The travels and experiences of an American operator, if written with spirit, power, and good taste, would "make a hit."

Notes.

MR. JAMES TYMAN writes to a recent number of *Design and Work* to say that he has successfully applied Herr Glafscorp's electric light to his bicycle. The motor is the hind wheel of the bicycle, and the machine is a small ordinary magneto electric machine with rotary magnet, aided by a small pocket battery. The carbons are regulated by a train of wheels, actuated by the front wheel of the bicycle, the consumption being about one inch per hour. The apparatus takes up the room of a small valise, and has cost in all about £5. The light is steady and equal to 120 candles, its great advantage being that it lights up the road thoroughly for 200 yards a-head on a dark night.

MAGNETIC SLEEP.—In an interesting case recently tried at the Court of Session, Edinburgh, the plaintiff claimed £500 damages from the defendant, Mr. Joseph Agnew, a surgeon-dentist, of Glasgow, for injuries incurred by magnetic trances to which the defendant was in the habit of subjecting him. The experiments consisted in placing large magnets in front of, behind, and above the plaintiff's head, the magnets being connected to the head by magnetic chains. During these experiments, which were undertaken in secrecy, at the defendant's request, the plaintiff's mind became seriously affected, and after repeated *seances* he became insane, while losing his physical health also. The plaintiff was the shop boy of the defendant. The defendant stated that he was interested in the subject of

magnetic sleep, and had tried experiments, but without effect. The case has not been concluded.

THE UNSEEN UNIVERSE AND THE TASIMETER.—The extreme delicacy of Edison's tasimeter has been proved during the recent solar eclipse, and we now hear that the latest piercing project of Mr. Edison is to employ it in exploring those blue fields of the night sky, which to the eye are void of stars, in order to discover the unseen orbs which tenant them. His plan is to adjust the tasimeter to its utmost sensitiveness, then attach it to the exploring telescope, when, if in any particular direction of the latter there is a marked and invariable deflection of the tasimeter, it may safely be inferred that there is an unknown world in line. "Seeing," says the *Scientific American*, "that the tasimeter is affected by a wider range of etheric undulations than the eye can take cognisance of, and is with all far more acutely sensitive, the probabilities are that it will open up hitherto inaccessible regions of space, and possibly extend the range of our real knowledge as far beyond the limit attained by the telescope as that is beyond the narrow reach of unaided vision. Possibly too, it may bring within human ken a vast multitude of nearer bodies—burnt out suns or feebly reflecting planets—now unknown because not luminous.

WHEATSTONE'S automatic system has been introduced on the Odessa to Constantinople cable. The speed obtained is twenty-eight words a minute, whilst with the Morse, only ten to eleven words a minute were got.

THE *Journal Telegraphique* states that the telegraph lines of Servia and Roumania, interrupted during the war, are still in that condition.

ACCORDING to the terms of the agreement between Germany and Russia, which will be enforced on October 1, a fixed tariff per word has been substituted for the tariff for twenty words, hitherto in vogue between these countries. For an ordinary telegram a fixed tax of fifty centimes (without regard to number of words) and a tax per word of forty centimes will be charged. For an urgent telegram this rate will be tripled; and for a repeated telegram they will be raised by fifty per cent.

THE Italian telegraphic revenue for 1877 amounted to £313 16s. 9d.

THE electricians of the Australian Overland Telegraph Line have cured the hostile natives about Macdonald's Peak of a propensity to cut the wire, by connecting it to a powerful induction coil, and administering a small thunderstroke to the boldest of them. The "black" is not a very reverent individual, but he respects lightning.

IT is said that there are already 16,157 miles of wire working quadruplex, and 14,580 miles working duplex in America already.

TELEGRAPHIC PROGRESS IN AMERICA. In the *Telegrapher* of May 17, 1873, a contribution from Mr. F. L. Pope was printed, entitled "Twenty Years of Telegraphic Progress," which will be found of interest at the present time. Five years have passed since this article appeared, and the progress of the electric telegraph has been even more marvellous than during the years preceding. The miles of telegraph wire in use have within that time practically more than doubled. There are now over 300,000 miles of wire in actual use in this country, beside 64,000 miles of what is termed "phantom" wire, that is, additional circuits created by the introduction of duplex and quadruplex systems of telegraph. About 13,000 offices and over 20,000 persons are employed in the telegraphic service. The demand for telegraphic facilities constantly increases, and what the future may witness in telegraphic development it is as impossible to forsee now as at any previous time.—*Journal of the Telegraph*, U.S.

A MAGNETIC survey of the State of Washington, U.S., in connection with the weather service has been commenced. There will be 25 stations to determine the magnetic elements, and the work will take three years to complete.

RECENTLY has been issued in America a work entitled "*The Telegraph in America*," by Mr. J. D. Reid, who has been for several years engaged in its preparation. It is a record of the telegraph in America; its rise and development, and will be richly illustrated. The price is five dollars, and it can be had of Mr. Reid, P.O. Box 3393, New York. The late Mr. Orton took a great interest in the progress of this work.

AT Oswego, U.S. recently, a message running "Send one hundred currency 4 paid," was received by a "travelling operator" as follows: "Send one trunk red currants—4 paid." It is dangerous now to mention red currants within that operator's hearing.

ELECTRICITY AND THE CAMERA.—We learn from the *Operator*, U.S., that an old hulk called the *Royal George* was recently blown up by torpedoes at Willets Point, near New York, and successful negatives taken of the explosion by means of electricity. Gen. Abbott U.S.A., superintended the process. The torpedoes were fired electrically; while along the shore four cameras were pointed at the scene of the explosion. The shutters of the cameras were suspended by threads which could be burned by fuses ignited electrically, so that the shutters would fall at any desired time. A chronometric clock in circuit registered these times of closing the camera and obtaining the negative.

RELATIVE INTENSITY OF LIGHTS.—M. Bertin in a recent article in the *Journal de Physique*, on the electro-magnetic rotation of liquids, draws up the following table of intensities, the solar light being reckoned at 1,000: Electric light of *Alliance* machine, 250; Drummond light, regulated to noisy state, 24; Drummond light, regulated to ordinary state, 15; gas burner, with glass chimney, forced flame, 1½; gas burner, with glass chimney, ordinary flame, 1; Carcel lamp of Pictet, or Moderator lamp, large model, 1; star candle (five to the pound), ½.

A CORRESPONDENT to *Nature* points out that the spectrum of Jablochkoff's electric candle is a union of the electric and lime-light spectra.

LIGHTNING.—During one of the thunderstorms which have been so frequent recently, a harvest labourer, Edward Dennis, aged 60, was killed by lightning. His body was found between some shocks of wheat; and it is supposed that he was on his way to seek the shelter of some cottage when he was struck. He had left his sickle behind him. He was much discoloured about the face; his right whisker was singed off and there was a jagged wound on the right ear from which blood had issued. This wound was not such as might have been inflicted by an instrument. His clothing, from the upper part of his body downwards, was torn into shreds. His boots had been riven from his feet and were scattered about in scraps—the soles, which were nailed, having been separated from the uppers. His hat had also

been torn in pieces by the discharge, which had furrowed the ground for some distance around him.

ANOTHER interesting case of lightning-stroke was related in a recent issue of the *Lancet*. A shepherd, sheltering under a tree, felt a blow on the right shoulder, and, immediately loosing the use of his legs, sank to the ground. On being taken home he gradually recovered from the numbness in his limbs, but still felt severe pain in the back and legs. On examination, a symmetrical fern-like mark of a bright scarlet was found to brand his back obliquely from the right shoulder to the left hip. It was raised above the rest of the skin. The midrib was ¾-in. wide and there were six or eight fronds regularly arrayed. In time the figure gradually faded away. This case recalls that of Mrs. Pidgeon, at Torbay, which was fully described in *Nature* for March, 1875.

THE order for dismissal of the suit of Edison against the Western Union Telegraph Company, on the ground of the non-residence of the defendants, was rescinded by Justice MacArthur, in the Equity Court at Washington, July 20th. This will place the suit, which is to test the ownership of the patent for the quadruplex telegraph instrument, on the calendar to be tried on its merits.—*The Operator*, W.S.

BEADED LIGHTNING.—The attention of the Lit. and Phil. Soc. of Manchester has been drawn by Mr. St. J. B. Joule to a remarkable form of lightning witnessed by him on the evening of Aug. 16, last year. The chief peculiarity of the flash was its intermittent or dotted character, like the spark sent along the intermittent tinfoil circuit on Leyden jars for lecture illustration. Part of the flash was zig-zag, and the rest curved. A correspondent in *Nature* confirms the fact that lightning occasionally takes this form, which is called by him the punctuated" form; but on which we think we have bestowed a better name in calling it "beaded lightning." Since writing the above we learn that this rare phenomenon has been called "*chaplet du feu*," by M. Planté.

THE *Chicago Tribune* is responsible for a statement to the effect that during a recent thunderstorm in that city a little fair-haired girl, Lottie Guild, of four years, had her hair turned from a bright golden hue to blue-black, as well as the scalp of her head blackened, by the action of a lightning discharge down the chimney, which turned her out of her bed and covered her with soot. The hair has been washed in a strong solution of ammonia, but the stain appears to be indelible, although the hair is as silky as ever. This process of hair-dyeing is, we fear, too dangerous to become of general use; but it may well justify some new boon to elderly mankind in the shape of an "Electric and Magnetic hair-wash."

A STARTLING INVENTION.—The genius of America passeth all understanding. We learn that a man in this city (Cincinnati) has invented an automatic cradle so arranged that it is set in motion by the very cry of the infant itself. Mr. Edison's *forte* is automatic contrivances, and we would advise the inventor to say nothing about this invention until it is secured by letters patent. Mr. Edison undoubtedly has published a statement in some paper that he proposed to make a cradle which would operate on the same principle. We are not positive whether the sonorous vibrations produced by the child's voice acts upon a piece of carbon, causes a varying pressure on the same, and thereby affecting an electrical current which operates a mechanical contrivance or not, but in view of the fact that Edison has monopolised the whole field of invention, it is barely possible that this would-be inventor is a base deceiver, guilty of a "straight steal." This man is a German.—*The American Inventor*. [The peculiar advantage of a cradle rocked by the baby's voice is manifestly that the harder the child cried the faster would the cradle rock; a beautiful example of the fitness of things.]

ELECTRICAL APPARATUS FOR EXHIBITING THE ROTATION OF THE EARTH.—Mr. Geo. M. Hopkins, whose electrical gyroscope we illustrated in our number for August 15th, has applied the latter to demonstrate the earth's rotation. For this purpose the gyrating wheel with its electro-magnets is suspended by silk threads in the plane of the meridian, that is at right angles to the plane of the equator and parallel to the polar axis of the earth. The electrical contacts are made by metal discs carried by the wheel dipping into capacious mercury cups carried by the fixed support of the apparatus. A pointer attached to the wheel and a beam of light reflected from a mirror both serve to indicate on a scale the earth's angular velocity.

AT the Parisian electro-plating establishment of the Société du Val d'Osne, a process for coppering cast iron is carried on. The power is derived from steam and transmitted 400 feet by means of electricity in the following manner. The motive shaft drives a Gramme machine, and the current generated is led by wires to a second Gramme machine which is rotated by it. The second Gramme turns a third Gramme which generates the electro-plating current. The velocity is regulated by inserting resistance in circuit.

ELECTRO-TYPING CERAMIC WARE.—A new process for decorating glass and china ware with metallic films has been invented by M. Alexandre. A conducting metallic paste of special preparation is spread over the object, and the design is traced on the glass through this coating. It is then fixed by heating the object in an oven; and when the latter is quite cold it is immersed in the bath and the electro-plate deposited on the glass to the required thickness. The metallic design thus effected can be finished by chiselling or other means.

REACTION OF THE ELECTRIC SPARK IN FORMING PERSULPHURIC ACID.—M. Berthelot, with the view of preparing persulphuric oxide directly from oxygen and sulphur trioxide, passed the electric spark at a high tension through a mixture of the two bodies for some time. The gas in the tube diminished from 60 cc to 40 cc, and the sulphur trioxide was replaced by a body resembling the persulphuric oxide prepared from sulphur dioxide, and which on examination was found to have the same composition, $S_2 O_7$ Persulphuric oxide decomposes slowly when kept, yielding either sulphur trioxide or a mixture of that body with some undecomposed acid. Like ozone and hydrogen dioxide, persulphuric oxide decomposes by degrees when the external energy under the influence by which it is formed ceases.

In the formation of persulphuric oxide, an excess of oxygen is necesssary, otherwise the reaction is incomplete; which fact, according to the author, gives evidence in support of the double action exerted by the electric spark, which is capable of decomposing binary compounds into their elements, and recombining them to form more complex substances, until equilibrium between the decomposition into simple, and the formation of the complex compounds is established. Similar effects have been observed in the action of heat and light on bodies. The equilibrium which attends these syntheses may be explained as the result of the opposition of the two energies (chemical and calorific), the former of which causes the disengagement of large quantities of heat, and the latter

(luminous or electric) being accompanied by the absorption of heat.—*Journal of Chemical Society.*

M. BARTOLI has devised an ingenious apparatus for detecting very feeble currents, by causing the invisible bubbles formed on a platinum wire in water when a current is sent through it, to set up a violent ebullition in superheated water.

INTERFERENCE OF ELECTRIC SPARKS.—M. de Wall, finds that when two electric sparks are simultaneously, produced at the extremities of a short tube smoked inside, the two discharges give figures of interference in the form of a black ring at the middle of the tube. If the sparks are not quite simultaneous the ring is slightly displaced. This method might serve to determine the velocity of sound. It can also be employed to measure the speed of propagation of electricity in a conductor by causing a spark to blaze forth at the middle, and another at the end of a long wire. It would be necessary, however, for this purpose, to obtain complete symmetry at the extremities of the tube, and to ensure that the two waves produced are identical. When the spark is from a battery discharge, the ring examined by microscope, is seen to be formed of several rings due to the oscillating discharge. From the position of these rings, it follows that the partial discharges are separated by an interval of about a quarter of a millionth of a second.

EDISON'S CARBON RHEOSTAT.—A very neat little rheostat based on the variable resistance of fine plumbago under pressure has been devised by Mr. Edison for quadruplex purposes. It consists mainly of a hollow cylinder of vulcanite standing on a brass baseplate, and containing a pile of fifty circular discs of silk cloth which have been treated by being steeped in sizing, well rubbed with fine plumbago, and then dried. These discs are both elastic and conducting. A metal disc or piston rests on top of them and a vertical screw with graduated head works in the top of the cylinder against the piston. By means of this screw, pressure is applied to the discs, and the degree of compression is indicated on the scale of the screw head by an index. According to the well known principle, an increase or decrease of pressure on the prepared discs is followed by a diminution or augmentation of their resistance as the case may be. By suitable terminals the current is sent through the whole pile. It is stated by the *Scientific American* that the resistance may in this way be varied from 400 to 600 ohms. It appears to us that the principal merit of the contrivance is the fine graduation of resistances it admits of.

DILATATION OF MAGNETISED CORES. — Messrs. Andrew and David Gray, of the Physical Laboratory, Glasgow University, have applied Edison's micro-tasimeter to the measurement of the lengthening and shortening of a bar of iron produced by magnetisation and de-magnetisation. The magnetic effect was produced by the current from three of Thomson's Tray Daniell cells, sent through a rough electro-magnet, formed of four layers of six turns each of insulated wire surrounding a tube containing the iron wire to be magnetised. A deflection of fifty divisions on the sensitive scale of a reflecting galvanometer in the Wheatstone Bridge circuit indicated the elongation on magnetisation. Further results of a quantative kind are promised.

ELECTRIC RESISTANCE OF MERCURY ON HEATING.—Herr J. Rink, from experiments on seven one-metre long columns of mercury finds the co-efficient for increase of electric resistance due to heat to be 0·000989 for each degree Celsius.

ELECTRICITY AND THE CAMERA.—It is an advantage in taking photographs to be able to expose the sensitive plate to the object at the proper moment, without going near the camera for that purpose. This is especially the case when photographing babies who are alive to the conspiracy going on about them. Mr. Cowen of Porchester Terrace, Southport, has devised a simple means whereby the shutter of the camera can be opened edgewise by means of a small battery—the contact being closed by a press-button in the operator's hand. A constant battery fitted in a box is set on the camera-stand, and is so small as not to interfere with the portability of the apparatus. The makers of this patented appliance are Messrs. Cusson and Co., Southport.

WE also hear from the star-shooting side of the Atlantic that a Californian photographer, Mr. E. J. Muybridge, has, by means of a series of cameras standing 1 ft. apart, and operated by electricity, succeeded in taking negatives of every phase of the action of a trotting horse in taking a complete stride. The means whereby this experiment was effected are more apparent to us than its object; but we suppose it has its own importance for lovers of fast-trotting. The various phases of the complete stride combined in the magic-lantern would, no doubt, furnish a rare treat for the horsey man.

ELECTRICITY AND THE LOOM.—Many different kinds of "stop-motions" have been introduced into textile machinery for the purpose of stopping the loom automatically, when, from some cause or other, such as the breaking of a yarn, it begins to perform its work improperly. These purely mechanical contrivances are all more or less delicate, but an electrical stop-motion, not open to this objection, has been invented by Messrs Bullough and Smalley, and applied to the cotton machinery of Messrs. Howard and Bullough, Accrington. The current is supplied by a small magneto-electric machine, weighing a few pounds, and driven by a strap from the main shaft. The current from this machine is so applied that when contact is made by the breaking yarn, or other cause, it traverses an electro-magnet which causes a soft iron armature to drop into a ratchet wheel, whose motion being impeded, makes the strap work upon the loose pulley, and thus stops the machine. This stop-motion is applied to the carding engine, the drawing frame, and a roving frame. In the drawing frame the insulating property of dry cotton is taken advantage of in closing the circuit This invention is giving great satisfaction to the cotton spinners of Lancashire. A full account of it was recently read before the Scientific and Mechanical Society of Manchester by Mr. W. H. Bailey.

WE illustrate in this issue the electro-magnetic "crown telephone" of Mr. Phelps, which is used in America as a receiver to Edison's transmitting telephone.

BY a recently concluded agreement, the directors of the Eastern Extension Australasia and China Telegraph Company, have practically decided to duplicate the cable between Port Darwin and Singapore. The South Australian Government, on their part, has undertaken to put into thorough working order the land line between Port Darwin and Port Augusta. The concurrence of the New Zealand Government has yet to be obtained before the scheme is finally settled, but there seems but little doubt that there will be any difficulty on this point.

MESSRS. NEWBURG and Co., of Vienna, propose to coat metals with tin by the electrotype process, employing a chromic acid battery for the purpose. The bath in which the articles to be tinned are immersed contains a solution of protochloride of tin and cream of tartar. The deposit being of a dead nature the articles are held over a fire after the electro deposit has taken place, and this gives them a lustrous appearance.

MR. ADOLPH C. WENGEL, of New York, has devised a method of overcoming the difficulty that attends the operation of making plates of pure nickel for battery anodes. For this purpose he employs ordinary grain metal, and this is held in a flat box of carbon perforated with holes, so that the solution in which this box is immersed comes in contact with all the grains of nickel whilst these grains are all in electrical connection with the pole of a battery through the medium of the carbon box which is itself connected to the battery.

THE form of sounder devised by Mr. Elisha Gray, of Chicago, has been adopted for use by the Postal Telegraph Department.

M. COCHERY, the director of the French postal telegraphs, is now in London with the view of introducing any improvement in the French service which may be suggested to him by the working of the English telegraph system.

LLOYD'S agent at Singapore, in a telegram dated September 24th, reports that the telegraph steamer *Edinburgh*, belonging to the Eastern Extension, Australasian, and China Telegraph Company, had gone ashore near that place, but was likely to be got off without damage.

A COURSE of lectures on Experimental Physics, including the Elements of Telegraphy and Electrical Measurements, will be held at the Birkbeck Literary and Scientific Institution by Mr. W. J. Wilson, F.C.S., M.S.T.E., commencing October 4th.

THE South Eastern Railway Company have now fitted to all their trains electrical communication between passengers and guards, the system being that devised by Mr. C. V. Walker. We learn the Brighton Company are also following the example of their neighbours by fitting up a similar apparatus on their own line.

MR. WILDE, of Manchester, has, we hear, received a second order from the Admiralty for electric light apparatus.

New Patents.

3134. "Apparatus for the dynamical production and application of electricity, and for its regulation when applied for illumination."—C. H. SIEMENS (communicated by E. W. Siemens and F. H. Von Alteneck). Dated, August 8.

3217. "An improved method of and apparatus for the transmission of signals by electricity between railway trains and stations, or other parts of the line, and for similar purposes."—W. R. LAKE (communicated by A. Cattaneo). Dated, August 14.

3250. "Producing and regulating electric light."—H. WILDE. Dated August 17.

3315. "Apparatus for electric lighting."—C. W. SIEMENS. Dated, August 22.

3317. "Galvanometers."—E. A. OBACH. Dated August 22nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

4468. "Apparatus for the electric transmission of telephonic communications."—L. M. DE BEJAR Y O'LAWLOR. Dated, November 27, 1877. 6d. This consists in combining the speaking telephone with the "Auto-kinetic" system (patented by Alexander Brown, No. 2327, 1873, and L. M. de Bejar, O'Lawlor, and N. A. Calvo, No. 1303, 1876), whereby one wire serves to convey a number of telephone messages from separate points to one central station.

4893. "Dynamo-electric and magneto-electric machines." A. M. CLARK (communicated by Lontin & Co., Paris). Dated, December 24, 1877. 4d. This consists in a dynamo-electric machine which dispenses with commutators or collectors by the circular motion of a coil between two similar magnetic poles producing four currents all in the same direction. This is effected by causing the coil, when receding from a pole, to be completely reversed so as to present to the said pole the opposite end to that which it presented on approaching the latter.

4934. "Electric Telephony."—CHARLES WEIGHTMAN HARRISON. Dated, December 29. 6d. This consists of making speaking telephones out of thermopiles, on which the warmth of the breath plays in speaking; and also out of a battery circuit, in which there is a breach filled up by a liquid or other resistance capable of being varied under pressure of the air vibrations; these vibrations being directed against the electrode (which may be flat or curved surfaces) dipping into the intercalated conductor. Curiously enough, figure 4 of this patent describes an adjustable microphone in everything except the battery, which is left out under the impression that being a thermopile no battery would be necessary, since the warmth of the breath would work it. An interesting point about this patent is the description and illustration of a form of carbon microphone, adjustable and actuated by a carbon zinc pile, with a sheet of cloth moistened with saline solution between the plates. An upright plate of carbon rests its lower end in a groove cut across the upper surface of the carbon plate of the pile, and is adjusted by a screw. In fact, it is a sort of portable microphone, such as is sold by Mr. Lancaster, the instrument maker. The author of this patent shows that he was unaware how nearly he had come to making a great discovery. The patent continues: My invention relates thirdly, to the employment of flat or other spirals or coils of wire attached at each end, or at stations on the line wire. The words to be conveyed are spoken on to one or more of these coils and received at the other end by similar coils. The coils may be employed with or without a local battery. Sometimes the coils are made a source of electricity by being constructed compound, *i.e.*, of more than one metal; or by coating them with magnetic sand, or by other suitable means. In my experiments I have found that the conducting wire of the circuit will produce sonorous vibrations in accordance with the variations in the current. For this purpose, I prefer that the spiral should be of soft iron, and that it should be stretched over a sounding board with a moderate degree of tension. The spiral is supported at its nodal points; in order to converge the sound upon them a trumpet mouthpiece may be placed over them. The spirals have been found suitable for placing in circuit with a standard clock, and thus serving as chronophones for repeating the hour in different places. The receiver is electro-magnetic—the diaphragm being

as thin as possible at the centre and increasing to seven or eight times its central thickness at the circumference. The north pole of the magnet is arranged opposite the centre of the disc, and the south pole at the margin. When it is desired to keep a record of the sounds, a means of indenting them on a moveable surface is provided.

General Science Columns.

THE DETECTION OF FIRE-DAMP. — Professor G. Forbes, of Glasgow, brought before the Mathematical and Physical Section an ingenious and novel device for detecting the presence of fire-damp in coal mines. Nothing could be simpler than the plan proposed by Professor Forbes; simply a tuning-fork of definite pitch, vibrating before a resonant tube, the loudness of the resonance depending on the nature of the gas with which the tube is filled; so that when fire-damp replaces the air in the tube, the resonant tube must be lengthened, inasmuch as the velocity of sound is greater in fire-damp than in air, and the amount of lengthening indicates, with proper precautions, the approximate amount of fire-damp present. The resonator is a metal tube, one inch diameter and fifteen inches long, in which a piston slides so as to regulate the length of the tube. The tube is fixed to a block of wood, to which is attached a tuning-fork, the prongs of which are just above the open end of the tube. The tuning-fork is sounded in any convenient way, and the piston is moved out and in until the proper length is found, which is indicated by the resonator intensifying the sound of the tuning-fork. With practice, the precise length can thus be tetermined with an accuracy of at least one in 250. But the length depends on the density of the gas—a light gas requiring a longer resonator, and by reading off on a scale the position of the piston a person can judge of its density. In this manner one or two per cent. of fire-damp mixed with common air can be detected. Barometric pressure produces no difference on the instrument. The temperature correction is made by reading off a thermometer whereon are marked the necessary corrections. The only error is by the presence of dense carbonic acid gas. But carbonic acid gas tends to destroy the explosive character of fire-damp, and it appears that if the presence of carbonic acid prevented the instrument from indicating fire-damp it would certainly be sufficient to prevent the explosive character of the fire-damp.

An electric arrangement to maintain the vibration of the fork, and thus at once to announce a change in the character of the atmosphere in the mine, would be a useful adjunct to this invention. We doubt, however, whether any contrivance of this kind suggested by Professor Forbes will be likely to come into use in coal mines; to a careful miner the change in the aspect of the flame of his Davy lamp is a sure warning of an influx of fire-damp, and to a careless miner no warning is of any avail. A more striking and more sensitive test of the presence of fire-damp was proposed some time ago by Professor Barrett, being founded on his discovery of the change in colour produced in a hydrogen flame by its contact with certain bodies. Carbonic acid gas and fire-damp give a characteristic colouration to the flame of pure hydrogen, and so marked and delicate is this re-action, that, as a rapid qualitative test, it might often be applied by the chemist. As regards its detection of carbonic acid gas, Professor Barrett's test would be a boon to stifling audiences in theatres and elsewhere if an Act of Parliament compelled the windows to be opened on the first signal given by the flame.

DURING the meeting of the British Association the Lord Lieutenant visited Mr. Grubb's famous astronomical works in Rathmines. It will be remembered that at these works were constructed the great Melbourne Telescope, and the several large equatorials lately erected in England for the Royal Society for Lord Lindsay for Oxford University, &c. Mr. Grubb has now in construction the largest refractor ever attempted. This instrument is 27 inches clear aperture, and will ultimately be erected at the new Imperial Observatory in Vienna. For this institution Mr. Grubb is also making the necessary domes and machinery: three great domes, each as large as that in the Greenwich Observatory, have already been dispatched, and the huge steel dome, 45 feet in diameter, which is to surmount the Great Equatorial Room in Vienna, is now complete, and ready for transit. This is the largest observatory roof in the world, and when we remember that it is necessary that this ponderous roof of 15 tons weight must be moved round and manipulated with one hand, the nature and difficulties of the work may be appreciated. A few years since almost all astronomical instruments were obtained from Germany; the last few years have seen the creation of an astronomical manufactory in Dublin employing exclusively Irish workmen, and competing successfully against foreign manufacture, outstripping not only the astronomical works of England, but even those abroad, which formerly supplied all such instruments to the world; the last few years having seen more than £15,000 worth of astronomical instruments manufactured for Germany alone.

WHEATSTONE'S MICROPHONE. — *History.*—Upwards of fifty years ago the name microphone was given to an instrument by Sir Charles Wheatstone, in a paper entitled "Experiments on Audition," published in the *Quarterly Journal of Science* for 1827. In this paper Wheatstone remarks:—"The great intensity with which sound is transmitted by solid rods, at the same time that its diffusion is prevented, affords a ready means of affecting this purpose [the augmentation of external sounds], and of constructing an instrument which, from its rendering audible the weakest sounds, may with propriety be named a *microphone*" It must be borne in mind, continues the distinguished author, that "the microphone is only adapted for hearing sounds when it is in immediate contact with sonorous bodies; when sounds are diffused by their transmission through the air the instrument will not afford the slightest assistance."

Hughes' Microphone.—It is perhaps needless to remark that the electric microphone, discovered this year (1878) by Professor Hughes, has nothing in common with the foregoing instrument except its delicacy in the detection of feeble sonorous vibrations in solid or liquid bodies.

In Hughes' microphone an electric circuit must be made from some voltaic cell through a fragment of carbon, resting on another fragment, and to an attached telephone, which may be miles away; under such circumstances any slight movements communicated to the carbon microphone—even such as are not sonorous—produce fluctuations in the strength of the electric current which are instantly revealed by an audible quivering in the disc of the telephone. In Wheatstone's microphone, electricity plays no part, the sonorous vibrations are transmitted by conduction along the metal rod to the ear, and reach the auditory nerve chiefly by conduction through the bones of the skull, and only in part by the ordinary channel of hearing, namely, the external meatus, tympanic membrane, &c.

Experiments.—Numerous experiments with this simple instrument will suggest themselves, but the following

among others suggested by Professor Barrett, cannot fail to be successful. In every case *place the cups one on each ear, and let the point depend*:—

1. Draw the feather of a quill over the point, every motion of the feather will be loudly heard. Try the same experiment when the cups are not on the ears, nothing can be heard.

2. Gently tap the point with a penholder or pen knife, a deafening sound will be heard.

3. Place the point on the face of a watch, the ticking of the watch will be distinctly heard, or the watch may be placed at the end of a long wooden or metal rod—on an iron fence, for example—and the ticking will thus be heard through a great length of conducting material.

4. Press the point against the sides of a kettle of water at or near boiling; the ebullition of the water will be heard with surprising loudness.

5. In like manner the falling of coarse sand through a sand glass may be heard, or the movement of water through the water pipes when a distant tap is opened.

6. Enclose one or two flies in a match box, and gently touch the box with the point of the microphone; the crawling of the flies will be distinctly heard. If a blue bottle fly be enclosed, and the box slightly opened, but not so far as to permit the escape of the prisoner, the efforts of the fly to release itself will be loudly heard, together with every separate kick given by the little prisoner against the walls of its prison.

7. That a large part of the sound heard is transmitted by conduction through the bones of the skull, and not through the mechanism of the organ of hearing, may be proved by fixing the cups of the microphone on each side of the head, just above or below the ear, the scraping of a feather on the instrument will still be heard, but not quite so loudly as before.

8. Again, a small tuning fork when struck, and the stem placed anywhere on the head, will be heard loudly. If both ears be stopped by the fingers, the fork will be heard much louder, and if one ear be unstopped the fork will appear to sound in the ear that is *stopped*, although it may be held quite close to the unstopped ear. Wheatstone notices this, and the cause probably arises from the resonance or sympathetic vibration of the air within the closed cavity of the ear, producing thereby a reinforcement of the sound on that side.

9. A striking experiment on the conduction of sound may be made by tying the knob of an ordinary poker to the centre of about a yard of tape; on holding the ends of the tape tightly against each ear, and so freely suspending the poker, a simple Wheatstone's microphone may be made. Gently striking the poker and allowing it to ring, a sound will be heard resembling the deep booming of the great bell of St. Paul's.

10. Wheatstone's microphone may be employed in the investigation of the state of sounding bodies; the position of nodal surfaces and ventral segments in organ pipes and other acoustic instruments may be searched out.

The following experiments are given by Wheatstone himself:—

11. If a bell be rung in a vessel of water and the point of the microphone be placed in the water at different distances from the bell, the difference of intensity will be very sensible.

12. If the point of the microphone be applied to the sides of a vessel containing a boiling liquid, or if it be placed in the liquid itself, the various sounds which are rendered may be heard very distinctly.

13. The instrument affords a means of ascertaining, with considerable accuracy, the points of a sonorous body at which the intensity of vibration is the greatest or least; thus placing its point on different parts of the sounding-board of a violin or guitar whilst one of its strings is in vibration, the points of greatest and least vibration are easily distinguished.

14. If the stem of a sounding tuning-fork be brought in contact with any part of the microphone, and at the same time a musical sound be produced by the voice, the most uninitiated ear will be able to perceive the consonance or dissonance of the two sounds; the roughness of discords and the beatings of imperfect consonances are thereby rendered so extremely disagreeable, and form so evident a contrast to the agreeable harmony and smoothness of two perfectly consonant sounds, that it is impossible that they can be confounded.—*Quarterly Journal of Science*, 1827, Part II.

The Para and Ceara Rubbers.—We are indebted to the *Journal of the Society of Arts* for the following new information about the Para and Ceara rubbers, which has been derived from the report of Mr. Robert Cross to the Secretary of State for India. Mr. Cross calls attention to the gnarled and warty state of the base of rubber trees, caused by the method of milking the trees, by cutting into the trunk with a hatchet, so as not only to pierce the bark, but the wood itself, a proceeding quite unnecessary since the juice flows between the wood and bark. The gashed wood heals again, but only at the expense of the bark, which is thinner over the wound, and the general vitality of the tree. The result is that the flow of milk year after year becomes lessened, and in a few years the tree dies in its prime. This evil once recognised can, however, be remedied. A moist, deep, heavy, fertile soil, but not necessarily inundated at any season of the year, is that best adapted for the rubber tree. There seems to be no appreciable difference in the quality of the rubber, whether collected in the dry or in the rainy season. It may be, however, that in the wet season a larger proportion of water is contained in the caoutchouc, while on the other hand a larger quantity of milk flows. The dry season is, in fact, the most suitable for caoutchouc collecting. The drying of the rubber juice in the smoke of burning palm seeds (which are said to be those of the *Euterpe Edulis* and a species of the *Attalea*) has given rise to an opinion, always stated by travellers, that the smoke produced by these burning nuts exercises some peculiar effect upon the milk, by which it coagulates almost instantly. After a careful examination of this matter, Mr. Cross expresses it as his conviction that the rapid coagulation of the milk is simply produced by the high temperature of the smoke, and that with a strong current of heated air, or a good pressure of steam from a pipe, a similar result would be obtained. He says: "I have no hesitation in giving my opinion that an equally good rubber could be prepared by putting the milk into shallow vessels, and evaporating the watery particles by the heat of boiling water." Mr. Cross brought home seeds and plants of the true Ceara rubber, which is now proved to be the produce of *Manihot glaziovii*, a plant distinct from the Para rubber tree, but a member of the same family—the Euphorbiaceæ. Ceara rubber is collected in a manner different to Para rubber. The outer surface of the bark of the trunk is pared off to a height of four or five feet; the milk then exudes and trickles down in an irregular manner, falling, for the most part, on to large leaves that are laid about the base of the trunk to receive it; some, however, often drops on to the ground, and so often gathers up with it dust and loose stones. After several days the juice becomes dry and solid, and is then pulled off and rolled up into balls, or put into bags in loose masses. The trees are badly treated, the tapping being made too deeply in the wood, so that

many trees are in a state of decay. From the fact that Ceara rubber occupies a good place in the market, being exported at the rate of about 1,000 tons per annum, it is to be hoped that more care may be taken of the trees, and that it may be successfully established in India. Mr. Cross recommends the hottest, low-lying, moist tracts of the Malay peninsula, Burmah, Ceylon, and Southern India for the Para rubber tree, and the districts of Madras, Cochin, Calicut, Cannanore, Mangalore, Bombay, and, indeed, all the parched regions of India within the limits of coffee culture, for the Ceara tree.

A COMPANY has been formed, under the presidency of Senator Pierce, for the purpose of transmitting some of the water power of Niagara, by means of compressed air, to the city of Buffalo, a distance of twenty-two miles. It is calculated that power sufficient to raise 350,000 gallons of water 150 feet will be obtained per minute by this plan, a power capable of working all the mills and factories in Buffalo.

City Notes.

Old Broad Street, September 27, 1878.

AT the tenth half yearly general meeting of the Direct Spanish Telegraph Company, held on the 26th inst., the Chairman, in moving the adoption of the report, an abstract of which was given in our last issue, said that the shareholders would hear with satisfaction that the cables of the company were in the same high electrical condition as at the time of the last report; and in the reports which they had since had from their electrician, the condition of the cables was stated to be as satisfactory as ever. He was glad to say that the hopeful signs of a revival of business in Spain, which had begun to manifest itself in increased receipts from the beginning of August, had continued, and had resulted in the month of September to a considerable further increase. Last year the receipts for September were £812 os. 7d., and so far as they could judge from the days which had expired of the present month, their receipts would be over £1,000, showing an increase of more than 25 per cent. They did not like to prophecy as to the future, but still they were just at the beginning of the fruit season, the prospects of which were very good this year in Spain. As he had said the receipts for this month would be over £1,000, and supposing they averaged £1,000 a month for twelve months, they would be able to pay their preference dividend in full, put £700 to reserve, and pay 2s. a share on the ordinary shares; while a further increase of £50 a week for twelve months would enable them to put £1,800 to reserve and pay 4s. a share on the ordinary shares. The expenditure was about the same as usual.—Mr. Abraham Scott, a director, having seconded the motion, it was carried unanimously, and the dividend on the preference shares was declared. The usual complimentary vote closed the proceedings.

The directors of Reuter's Telegram Company (Limited) have declared an interim dividend at the rate of 5 per cent. per annum per half year ending June 30 last.

The Eastern Extension, Australasia, and China Telegraph Company (Limited) have declared an interim dividend for the quarter ended June 30, of 2s. 6d. per share, or at the rate of 5 per cent. per annum, payable on the 15th October.

At a meeting of the directors of the West India and Panama Telegraph Company (Limited), after deciding to place £5,000 to reserve, it was resolved to recommend to shareholders at the approaching meeting that a dividend at the rate of 1 per cent. per annum (free of income tax), on the ordinary shares of the company, be declared for the half-year ending June 30, 1878, in addition to the dividend at the rate of 6 per cent. per annum on the first and second preference shares of the company.

At a meeting of the board of directors of the Anglo-American Telegraph Company, held this day, it was resolved, after reserving £37,500 for the renewal fund, to declare an interim dividend for the quarter ending September 30 of 1¼ per cent. on the Consolidated Stock, and 2 per cent. on the Preferred Stock, leaving about £10,000 to be carried forward. The transfer books will be closed from the first to the 4th proximo.

The Great Northern Telegraph Company notified on September 20th that, owing to a typhoon, the Company's cables between Nagasaki and Shanghai and between Shanghai and Amoy are interrupted. The repairing steamer being on the spot, a speedy restoration is expected. Meanwhile, messages for Hong Kong and Amoy cannot be accepted, and messages for Shanghai will be forwarded from Nagasaki by steamer. The Company's lines to all Japanese stations work well. Since the above notification was issued, a service has been received from Shanghai. This message was sent from the repairing ship to Nagasaki, and it is therefore expected that the final splice of the cable will soon be effected.

The Eastern Extension Telegraph Company notify that their cable between Java and Australia is interrupted. Telegrams for Australia and New Zealand will be forwarded between the interrupted points until communication is restored by the special steamer chartered by the Australian Governments.

The steamship *Great Northern* has recently left Gravesend with about 500 miles of submarine cable on board for the purpose of connecting Cyprus telegraphically with Beyrout and with the Eastern Telegraph Company's cable at Alexandria.

The following are the late quotations of telegraphs:—Anglo-American, Limited, 61-61½; Ditto, Preferred, 90-91; Ditto, Deferred, 34¼-35; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 9⅛-9⅜; Cuba, Limited, 10 per cent. Preference, 15¾-16¼; Direct Spanish, Limited, 2-2½; Direct Spanish, 10 per cent. Preference, 9⅝-10⅛; Direct United States Cable, Limited, 1877, 13-13½; Eastern, Limited, 7⅛-7¼; Eastern, 6 per cent. Debentures, repayable October 1883, 107-110; Eastern 5 per cent. Debentures repayable August, 1887, 99-101; Eastern 6 per cent. Preference, 11½-11¾; Eastern Extension, Australasian and China, Limited, 7¼-7⅜; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; German Union Telegraph and Trust, 8-8½; Globe Telegraph and Trust, Limited, 5⅛-5⅜; Globe 6 per cent. Preference, 10⅞-11⅛; Great Northern, 8-8¼; Indo-European, Limited, 20-21; Mediterranean Extension, Limited, 3-3⅛; Mediterranean Extension, 8 per cent. Preference, 9½-10; Reuter's Limited, 10-11; Submarine, 216-221; Submarine Scrip, 1⅞-2⅛; West India and Panama, Limited, 2-2½; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8⅝; Western and Brazilian, Limited, 3-3½; Ditto, 6 per cent. Debentures "A," 93-96, Ditto, ditto, ditto, "B," 91-93; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 99-101; Telegraph Construction and Maintenance, Limited, 31¼-31¾; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅜-2¾.